CLAIMS

We claim:

1. A fuel injector having a nozzle with improved cooling for an internal combustion engine comprising:

a substantially tubular retainer having a proximal end with a nozzle support portion, said nozzle support portion having an outer peripheral surface and an engagement opening with an inner peripheral surface; and

a nozzle housing received within said retainer at said proximal end, said nozzle housing including a nozzle shank with a longitudinal axis, an outer peripheral surface and at least one injection hole at a tip of said nozzle shank which is adapted to spray fuel, said nozzle shank being positioned in said nozzle support portion of said retainer;

wherein said outer peripheral surface of said nozzle shank is tapered with respect to said longitudinal axis, and said inner peripheral surface of said nozzle support portion is correspondingly tapered with respect to said longitudinal axis and is sized to engage said outer peripheral surface of said nozzle shank along a tapered interface.

2. The fuel injector of claim 1, wherein a length of said tapered interface is greater than a diameter of said nozzle shank.

3. The fuel injector of claim 2, wherein said outer peripheral surface of said nozzle shank and said inner peripheral surface of said nozzle support portion are tapered between 0.5 to 15 degrees.

4. The fuel injector of claim 3, wherein said outer peripheral surface of said nozzle shank and said inner peripheral surface of said nozzle support portion are tapered approximately between 1 to 2 degrees with respect to said longitudinal axis.

5. The fuel injector of claim 2, wherein said nozzle support portion has an inverse conical shape with a conical outer peripheral surface.

6. The fuel injector of claim 1, wherein said retainer further includes a nozzle sleeve and said nozzle support portion is provided on said nozzle sleeve.

7. The fuel injector of claim 6, wherein said outer peripheral surface of said nozzle shank and said inner peripheral surface of said nozzle sleeve are tapered between 0.5 to 15 degrees.

8. The fuel injector of claim 7, wherein said outer peripheral surface of said nozzle shank and said inner peripheral surface of said nozzle sleeve are tapered approximately between 1 to 2 degrees with respect to said longitudinal axis.

9. The fuel injector of claim 6, wherein said nozzle sleeve has an inverse conical shape with a conical outer peripheral surface.

10. The fuel injector of claim 1, wherein the fuel injector is adapted to be received in an injector bore of a cylinder head of the internal combustion engine, and said outer peripheral surface of said nozzle support portion directly contacts at least one of the injector bore of the cylinder head and a coolant jacket sleeve installed in the injector bore.

11. The fuel injector of claim 10, wherein said outer peripheral surface of said nozzle sleeve directly contacts the coolant jacket sleeve installed in the injector bore.

12. A fuel injector having a nozzle with improved cooling for an internal combustion engine comprising:

a substantially tubular retainer having a proximal end with a nozzle support portion, said nozzle support portion having an outer peripheral surface and an engagement opening with an inner peripheral surface; and

a nozzle housing received within said retainer at said proximal end, said nozzle housing including a nozzle shank with an outer peripheral surface and at least one injection hole at a tip of the nozzle shank which is adapted to spray fuel;

wherein said inner peripheral surface of said nozzle support portion has a diameter smaller than a diameter of said outer peripheral surface of said nozzle shank in a manner that an interference fit exists at a seal interface between said nozzle shank and said nozzle support portion when said nozzle shank is installed in said nozzle support portion.

13. The fuel injector of claim 12, wherein the diameter of the inner peripheral surface of said nozzle support portion is sized approximately 0.00005 to 0.001 inch smaller than the diameter of said outer peripheral surface of said nozzle shank.

14. The fuel injector of claim 13, wherein the diameter of the inner peripheral surface of said nozzle support portion is sized approximately 0.0001 to 0.0006 inch smaller than the diameter of said outer peripheral surface of said nozzle shank.

15. The fuel injector of claim 12, wherein said nozzle support portion includes a chamfer adapted to facilitate installation of said nozzle shank into said nozzle support portion.

16. The fuel injector of claim 15, wherein the diameter of the inner peripheral surface of said nozzle support portion is sized approximately 0.00005 to 0.001 inch smaller than the diameter of said outer peripheral surface of said nozzle shank.

17. The fuel injector of claim 16, wherein the diameter of the inner peripheral surface of said nozzle support portion is sized approximately 0.0001 to 0.0006 inch smaller than the diameter of said outer peripheral surface of said nozzle shank.

18. The fuel injector of claim 12, wherein the nozzle shank is press fitted into said engagement opening of said nozzle support portion.

19. The fuel injector of claim 12, wherein said retainer further includes a nozzle sleeve and said nozzle support portion is provided on said nozzle sleeve.

20. The fuel injector of claim 12, wherein the fuel injector is adapted to be received in an injector bore of a cylinder head of the internal combustion engine, and said outer peripheral surface of said nozzle support portion directly contacts at least one of the injector bore of the cylinder head and a coolant jacket sleeve installed in the injector bore.

21. A fuel injector having a nozzle with improved cooling for an internal combustion engine comprising:

a substantially tubular retainer having a proximal end with a nozzle support portion, said nozzle support portion having an outer peripheral surface and an engagement opening with an inner peripheral surface;

a nozzle housing received within said retainer at said proximal end, said nozzle housing including a nozzle shank with an outer peripheral surface and at least one injection hole at a tip of the nozzle shank which is adapted to spray fuel, said nozzle shank being positioned in said nozzle support portion of said retainer; and

a nozzle seal adapted to seal an interface between said inner peripheral surface of said nozzle support portion and said outer peripheral surface of said nozzle shank to thereby prevent accumulation of hot gas at said interface.

22. The fuel injector of claim 21, wherein said nozzle seal is positioned between said inner peripheral surface of said nozzle support portion and said outer peripheral surface of said nozzle shank.

23. The fuel injector of claim 22, wherein said nozzle seal is a metallic washer.

24. The fuel injector of claim 23, wherein said metallic washer is made of at least one of steel and copper.

25. The fuel injector of claim 21, wherein said nozzle support portion includes a flange on said inner peripheral surface, and said nozzle shank includes an abutment on said outer peripheral surface that is axially spaced from said flange when said nozzle housing is received within said retainer, thereby forming a seal compartment between said inner peripheral surface of said nozzle support portion and said outer peripheral surface of said nozzle shank.

26. The fuel injector of claim 25, wherein said nozzle seal is a metallic washer disposed in said seal compartment.

27. The fuel injector of claim 25, further comprising a compliant ring disposed in said seal compartment adjacent to said nozzle seal to compensate for axial tolerance variances between said retainer and said nozzle housing when said nozzle housing is received within said retainer.

28. The fuel injector of claim 27, wherein said compliant ring has a C-shaped cross-section.

29. The fuel injector of claim 28, wherein said compliant ring is made of at least one of steel and copper.

30. The fuel injector of claim 25, wherein said retainer further includes a nozzle sleeve and said nozzle support portion is provided on said nozzle sleeve.

31. The fuel injector of claim 21, wherein the fuel injector is adapted to be received in an injector bore of a cylinder head of the internal combustion engine, and said outer peripheral surface of said nozzle support portion directly contacts at least one of the injector bore of the cylinder head and a coolant jacket sleeve installed in the injector bore.

32. A fuel injector having a nozzle with improved cooling for installation into an injector bore of a cylinder head of an internal combustion engine comprising:

a nozzle housing with an outer peripheral surface, a valve cavity therein, a valve seat disposed in said valve cavity, and at least one injection hole at a tip of said nozzle housing which is adapted to spray fuel; and

a valve element disposed in said valve cavity of said nozzle housing, said valve element being operable between a closed position in which said valve element is seated against said valve seat to thereby prevent injection of fuel through said at least one injection hole, and an open position in which said valve element is lifted off said valve seat to thereby allow injection of fuel through said at least one injection hole;

wherein said outer peripheral surface of said nozzle housing directly contacts at least one of the injector bore of the cylinder head and a coolant jacket sleeve installed in the injector bore.

33. The fuel injector of claim 32, wherein said outer peripheral surface of said nozzle housing is conical in shape and directly contacts said coolant jacket sleeve installed in the injector bore.